TR-159

TECHNICAL REPORT

A MARINE MAGNETIC SURVEY OF THE NEW ENGLAND SEAMOUNT CHAIN

PROJECT M-9

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ABSTRACT

A systematic geomagnetic and bathymetric survey of the New England Seamount Chain disclosed a close correlation between the magnetic and bathymetric features. A new seamount was discovered and other seamounts were charted in detail. Computer computations indicate that the seamounts have a large component of remanent magnetization and place the paleomagnetic pole position for Kelvin Seamount at 73° North and 43° East in the Barents Sea.

FOREWORD

This report presents geomagnetic data obtained during a recent geophysical survey in the Atlantic Ocean. Systematic geophysical investigations of the type described here are essential for developing an accurate and complete understanding of the geologic and crustal environment underlying the ocean basins.

DENYS W. KNOLL
Rear Admiral, U. S. Navy
Commander

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FIGURES

I. INTRODUCTION

In June, July, and August 1962, USS SHELDRAKE (AGS-19) conducted a systematic geomagnetic and bathymetric survey of the New England Seamount Chain. This survey was conducted as part of a U. S. Naval Oceanographic Office project to survey offshore areas not previously subjected to systematic surveys. The New England Seamount Chain is a series of ocean bottom features extending about 750 miles in a southeasterly direction from the northeast coast of the United States (Fig. 1).

This report is concerned primarily with the geomagnetics phase of the survey (U. S. Naval Oceanographic Office Project M-9). Bathymetric contour charts and profiles are included for correlation and interpretation purposes.

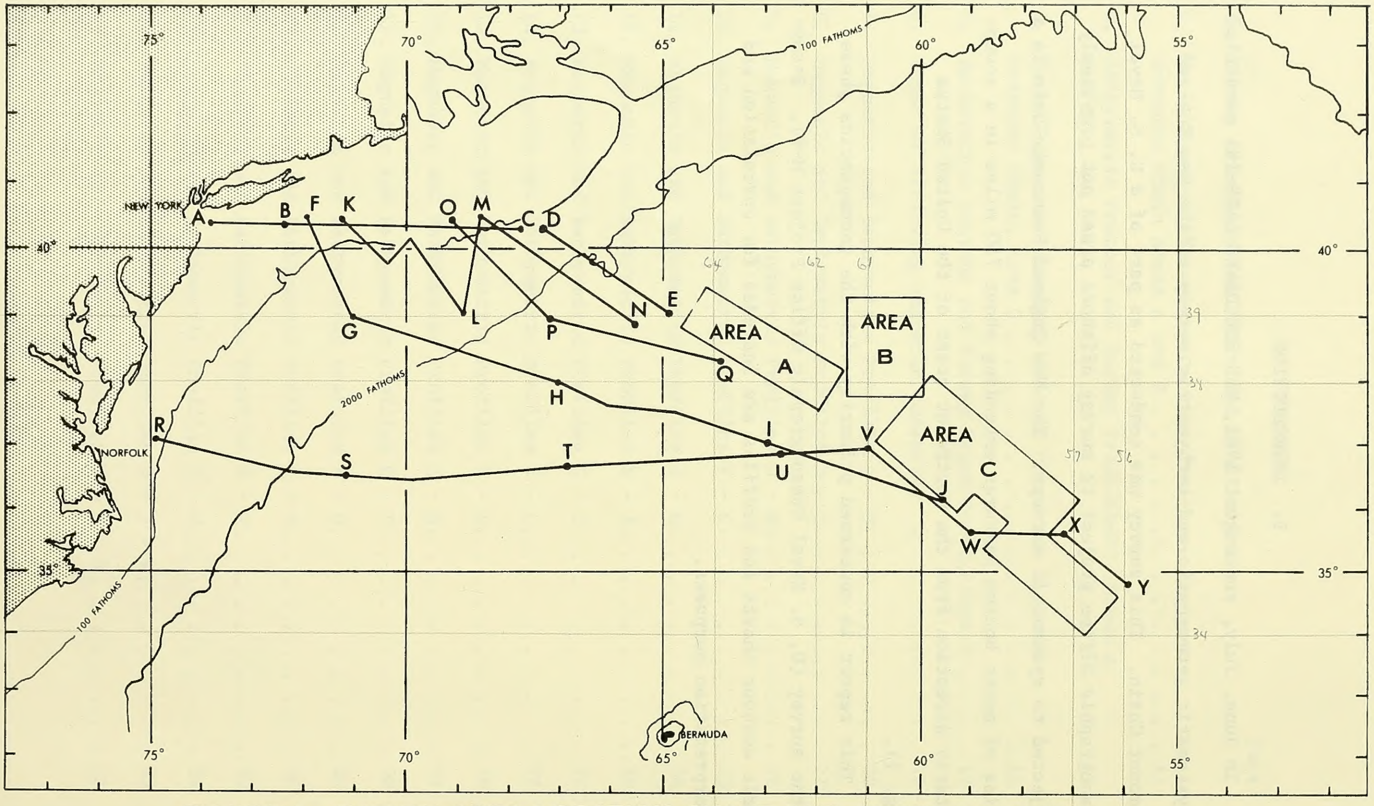

FIGURE 1.—SURVEY AREA LOCATION CHART AND PROFILE INDEX

II. SURVEY OPERATIONS

A. Conduct of Survey

The area surveyed was subdivided into three separate rectangles totaling about 30,000 square miles. This was done in order to cover all the known seamounts in the time available for the survey operations (Fig. 1). Survey lines in Areas A and C were run normal to the axial trend of the seamount chain at a spacing of five nautical miles. In Area B, lines were run at the same spacing, but in a North-South direction. The average ship's speed when surveying was 12 knots. Bathymetric and magnetic data were collected simultaneously along all survey lines.

Throughout the survey area, the ship's position was determined by Loran-A, and the fix time-interval was normally 15 minutes. Between the time of sunrise and sunset, fix accuracy was about $\pm$ 2 miles. Tracks run at night generally were dead-reckoned when Loran-A reception deteriorated because of local weather and sky-wave conditions. Strong westerly ocean currents in Area A and the western part of Area C made it difficult for SHELDRAKE to maintain the intended courses.

The survey of the seamount chain was accomplished in three phases of approximately two weeks each. Data were collected on four of five enroute tracks between New York and the survey area. Data also were obtained on the final track which terminated in Norfolk, Virginia. The tracks were spaced to make best possible use of the ship's survey capabilities (Fig. 1).

B. Instrumentation

Absolute total magnetic intensity measurements were made with a model V-4914 Varian proton precession airborne magnetometer, adapted for use as a marine survey instrument. The sensor unit was towed approximately 500 feet astern of the ship to minimize the effect of the ship's magnetic field. A toroidal-coil epoxy sensor, or "fish", was used successfully during the first two weeks of the survey. Its use then was abandoned when a loose electrical connection within the casting caused noise and loss of signal. During the remainder of the survey operations, a rebuilt Varian model XN-49-818 fish with omnidirectional coils gave excellent results. In both cases the hydrocarbon sample in the fish was ship's diesel oil.

The V-4914 instrument measures the intensity of the magnetic field by measuring the period of time required to count 1024 cycles of the proton precession frequency. This time measurement was accomplished by counting pulses of a 400 KC reference frequency during the 1024 cycle gate period. The reference frequency count was recorded in analog form on a Sanborn recorder. The sensitivity of the measurements was about $\pm$ 1 gamma.

Bathymetric data were recorded on a Precision Depth Recorder (MK XI) used in conjunction with an AN/UQN-1c Echo Sounding Set.

III. DATA PROCESSING

The strip-chart record of magnetometer counts is a non-linear inverse function of the earth's magnetic field strength. By means of a special template developed at the Oceanographic Office, the data tapes were scaled directly in gammas. Contour charts of total magnetic intensity (Figs. 2 and 4) were constructed from these scaled data using a contour interval of 50 gammas. Bathymetric contour charts (Figs. 3 and 5) were prepared using a contour interval of 100 fathoms. To show the density of the survey data, a track pattern is overprinted on the bathymetric contour charts.

Magnetic and bathymetric profiles taken along approximately 2600 miles of enroute tracks are presented in Figures 7 through 22. Several of the magnetic profiles are shown together in Figure 6 to illustrate zones of differing magnetic character. For ease of presentation in Figure 6, the earth's regional gradient was removed from the magnetic profiles.

No corrections to the magnetic data were made for temporal variations of the magnetic field. No sound velocity or other corrections have been applied to the bathymetric data.

IV. SURVEY RESULTS AND ANALYSIS

A. General

As a result of this survey, detailed geomagnetic data of the Abyssal Seamounts of the New England Seamount Chain now are available for geophysical analysis. The magnetic total intensity contours are shown in Figures 2 and 4; the bathymetric contours are shown in Figures 3 and 5. In general, a close correlation exists between the magnetic and bathymetric features. A description of these features and an analysis of the data follow.

B. Description of Features

1. Survey Area A. The Kelvin Group, referred to as a "Tri-peaked Bank" by Northrup, et al, 1962, appears as four separate features. Separating these seamounts are abyssal depths exceeding 2600 fathoms. The magnetic contours (Fig. 2) correlate closely with the bathymetric contours (Fig. 3). Each seamount, with one exception, has at least two peaks or is elongate in shape. The exception is a seamount, unknown prior to this survey, located at $38^{o}25'$ North, $62^{o}11'$ West. Additional lines were run to delineate its shape. A minor bathymetric feature of 200 fathoms relief is located at approximately $38^{o}29'$ North, $62^{o}33'$ West. Track spacing was not close enough to detail the shape of the feature. A broad 50 gamma magnetic "high" corresponds with this bathymetric peak.

2. Survey Area B. Area B covers San Pablo and Manning Seamounts. San Pablo Seamount is a twin-peaked feature with an associated twin magnetic anomaly. Manning Seamount has at least five separate peaks with a corresponding complex magnetic anomaly.

3. <u>Survey Area C</u>. Two large seamounts, Rehoboth and Nashville, and several groups of smaller peaks were surveyed in Area C. The twin-peaked Rehoboth has associated with it three magnetic "highs". The ridge-shaped Nashville Seamount has several magnetic contour closures. Other seamounts in the area have similar closely related magnetic features.

4. <u>Enroute Survey</u>. The magnetic and bathymetric data collected on tracks enroute to and from the survey area are shown in Figures 7 through 22. On profile A-B (Fig. 7), a 600 gamma anomaly was charted south of Long Island where the track crosses an anomalous trend described by Zurflueh, 1962. Profile D-E (Fig. 9) illustrates the typically strong magnetic character of three seamounts of the New England Chain. Other profiles are useful for showing the magnetic character of the earth's crust between the continent and the seamount chain.

Three zones of differing magnetic character, as seen in Figure 6, were described by King, et al, 1961. Zone 1, "The Bermuda High", is characterized by closely spaced anomalies of rather uniform size. The flatness of the bottom topography in Zone 1 may be noted by referring to the appropriate "Magnetic and Bathymetric Profile Sheets". Zone 2 includes broad anomalies of variable amplitude over the continental shelf and slope. Zone 3, lying between the first two zones, is characterized by relatively smooth profiles. Exceptions to the smooth nature of the magnetic field are anomalies caused by Caryn Peak and Bear Seamount

A seamount, which had been removed from bathymetric charts for lack of conclusive information, was located west of Nashville Seamount (Fig. 23). Time was not available for running additional lines over this feature.

C. Magnetic Data Analysis

Using data from this survey the magnetic polarization constants for Kelvin Seamount have been computed (Van Voorhis, 1963) using the method of Vacquier, 1962. The results of these computations indicate that Kelvin Seamount is highly magnetized and has a large component of remanent magnetization. The direction of total magnetization of the seamount was found to have an azimuth considerably east of and an inclination shallower than the present earth's field.

Paleomagnetic pole positions for Kelvin Seamount have been calculated using the computed direction of magnetization (Vacquier, 1963). These calculations locate the North Magnetic Pole at the time of the seamount's formation at 73° North and 43° East, in the Barents Sea. This position is not unusual, based on paleomagnetic studies of other rocks (Doell, 1961).

V. SUMMARY OF FINDINGS

As would be expected with seamounts of volcanic origin, there is a close correlation of the total intensity contours of the geomagnetic field with the bathymetric contours of the New England Seamounts.

As a result of computer computations of Kelvin Seamount, there is an indication that the seamounts are highly magnetized and have a large component of remanent magnetization. The remanence of Kelvin Seamount is not in the direction of the present inducing field. The calculated location of the North Magnetic Pole at the time of formation of Kelvin Seamount was found to conform with positions derived from other paleomagnetic studies.

A previously uncharted seamount was discovered at N 38°25' and W 62°11'. A second seamount, which had been removed from bathymetric charts because of uncertainty of data, was relocated west of Nashville Seamount.

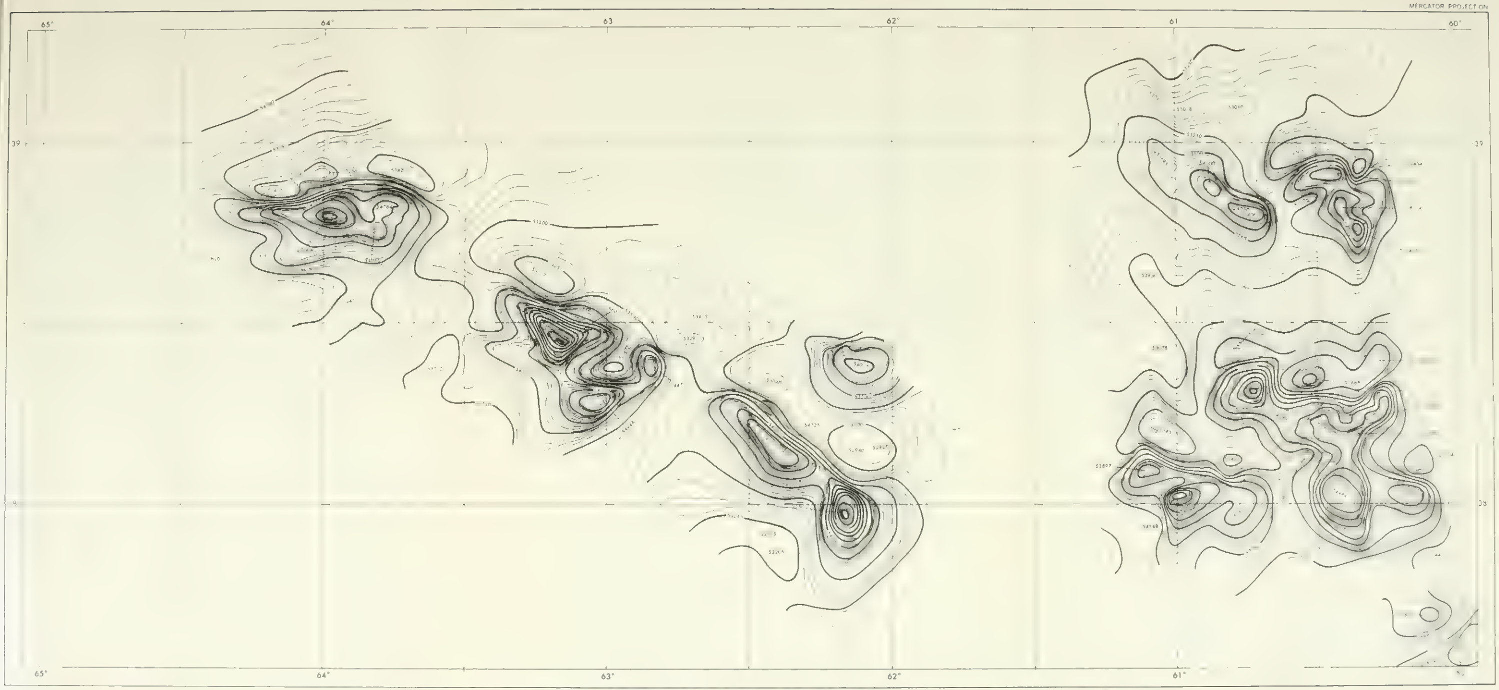

FIGURE 2.—TOTAL MAGNETIC INTENSITY CONTOUR CHART NEW ENGLAND SEAMOUNT CHAIN AREAS A AND B

CONTOUR INTERVAL 50 GAMMAS

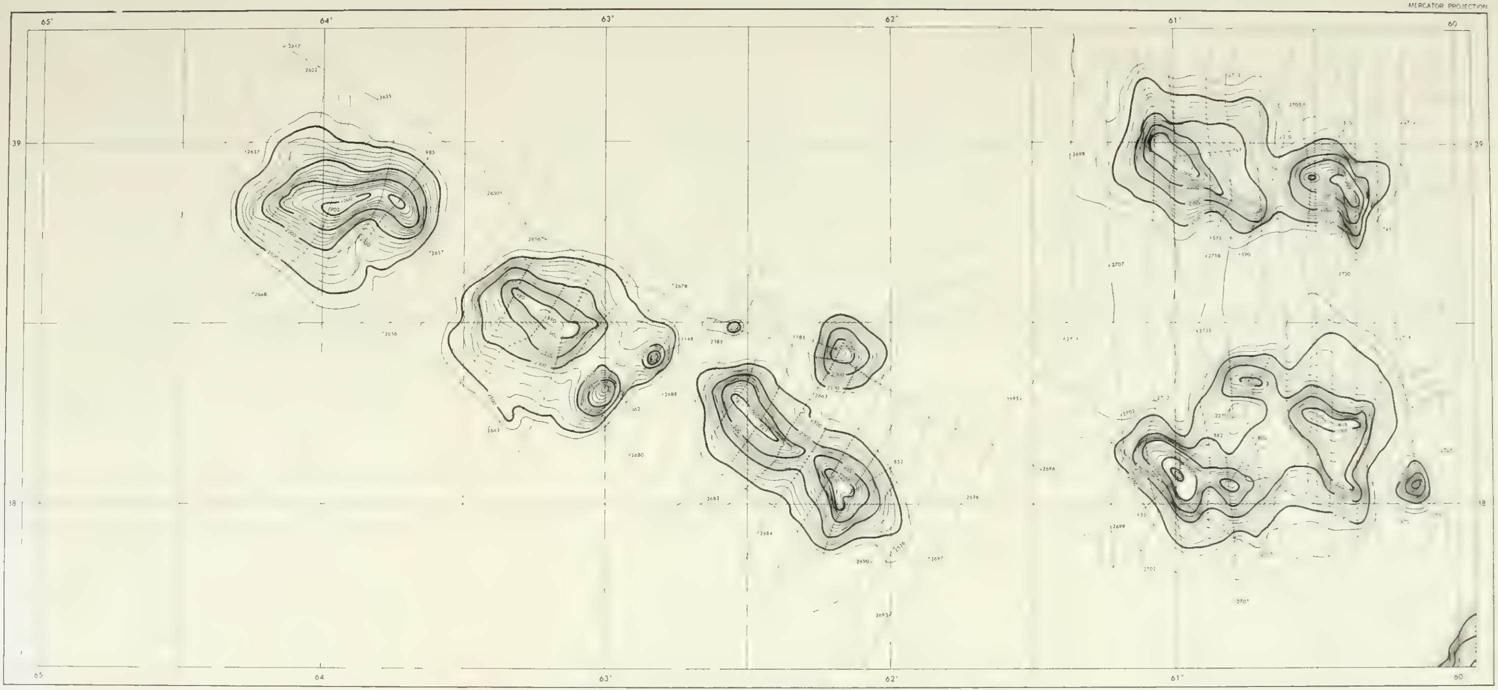

FIGURE 3.—BATHYMETRIC CONTOUR AND SURVEY TRACK CHART AREAS A AND B

CONTOUR INTERVAL: 100 FATHOMS

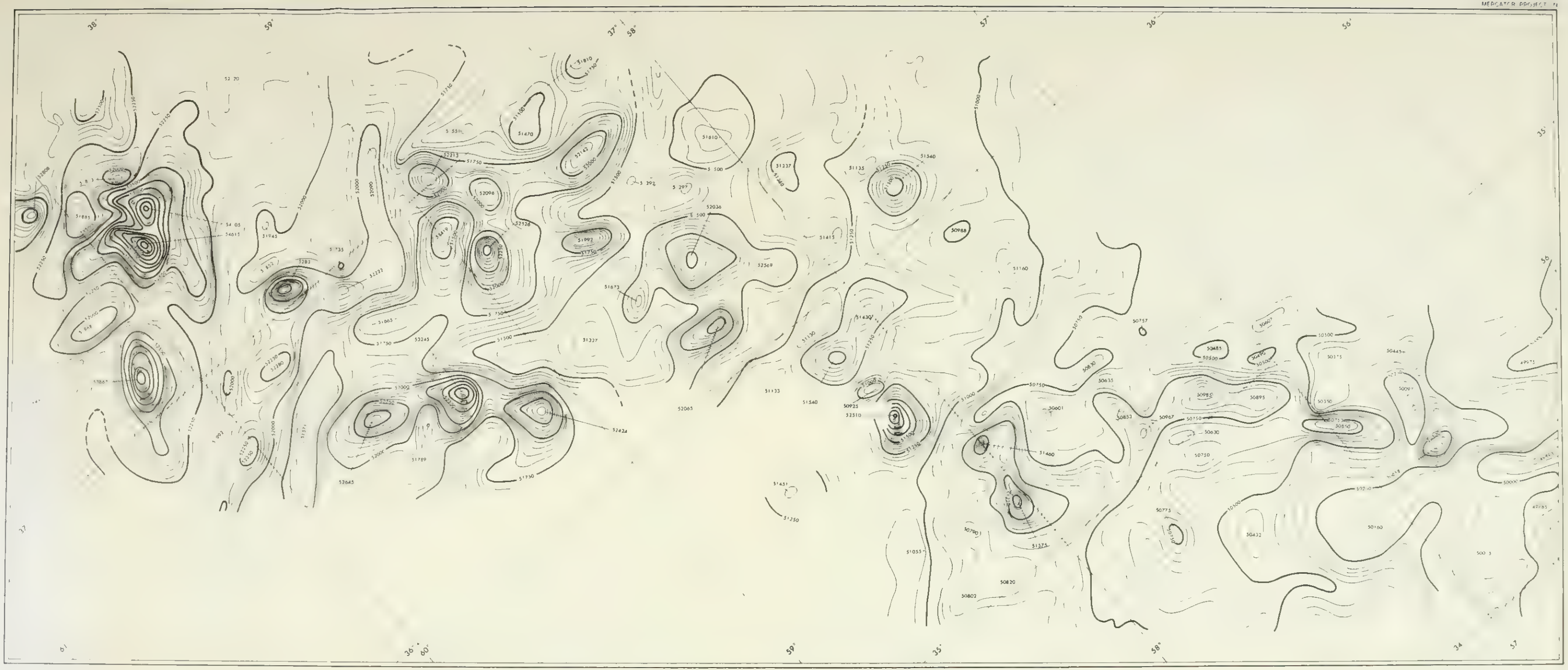

FIGURE 4.—TOTAL MAGNETIC INTENSITY CONTOUR CHART NEW ENGLAND SEAMOUNT CHAIN AREA C

CONTOUR INTERVAL 50 GAMMAS

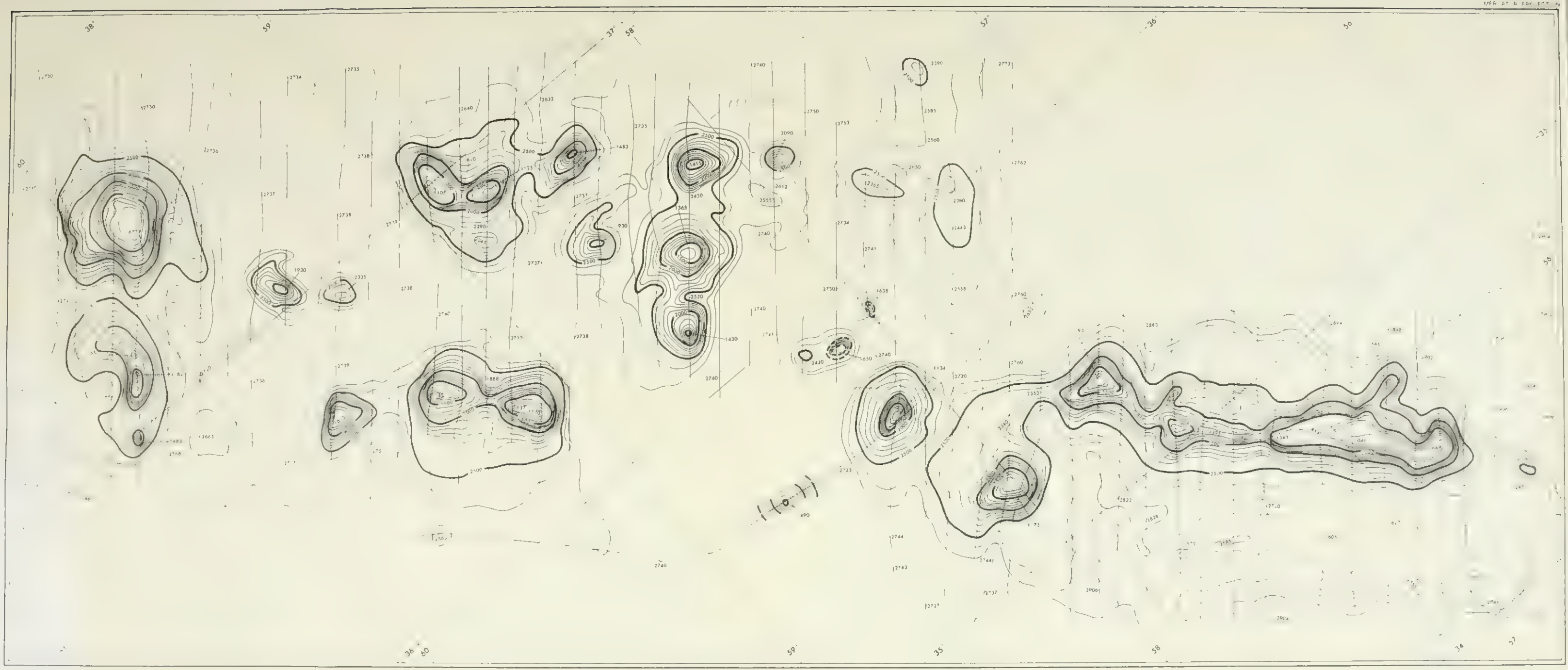

FIGURE 5.—BATHYMETRIC CONTOUR AND SURVEY TRACK CHART AREA C

CONTOUR INTERVAL. 100 FATHOMS

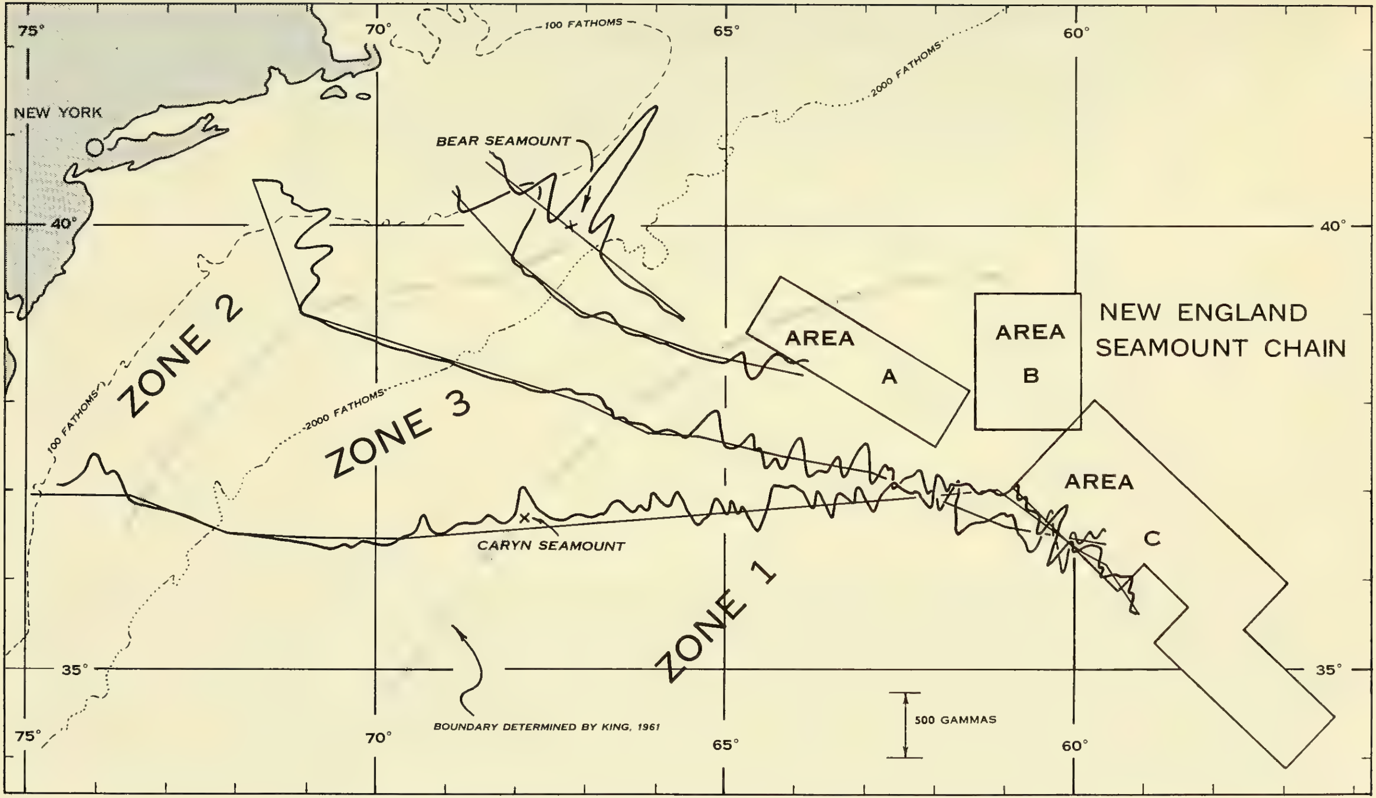

FIGURE 6.— ZONES OF DIFFERING MAGNETIC CHARACTER

MAGNETIC PROFILES ARE SHOWN ALONG SHIPS TRACKS TO AND FROM THE SURVEY AREAS.

FIGURE 7.—MAGNETIC AND BATHYMETRIC PROFILES A-B

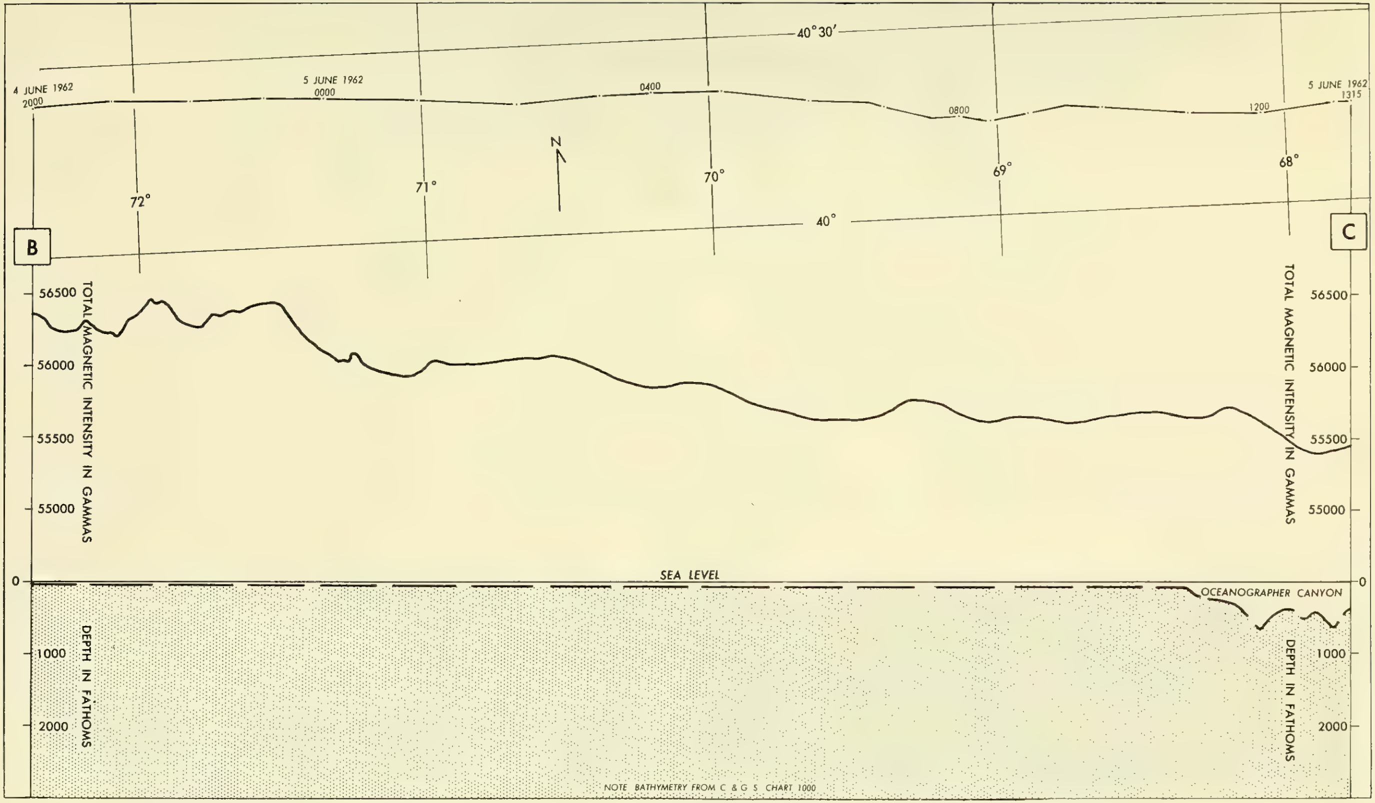

FIGURE 8.— MAGNETIC AND BATHYMETRIC PROFILES B-C

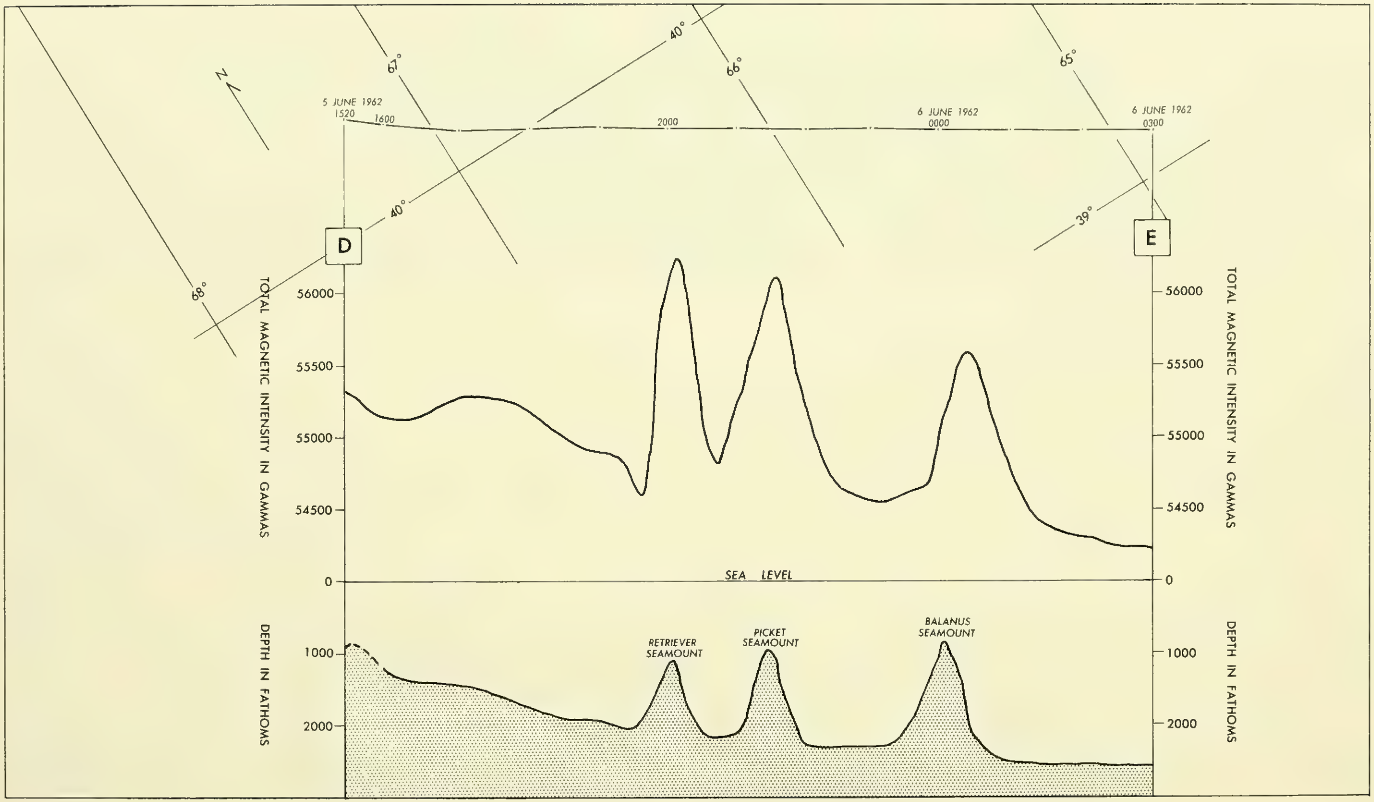

FIGURE 9.— MAGNETIC AND BATHYMETRIC PROFILES D-E

FIGURE 10.—MAGNETIC AND BATHYMETRIC PROFILES F-G

FIGURE 11.— MAGNETIC AND BATHYMETRIC PROFILES G-H

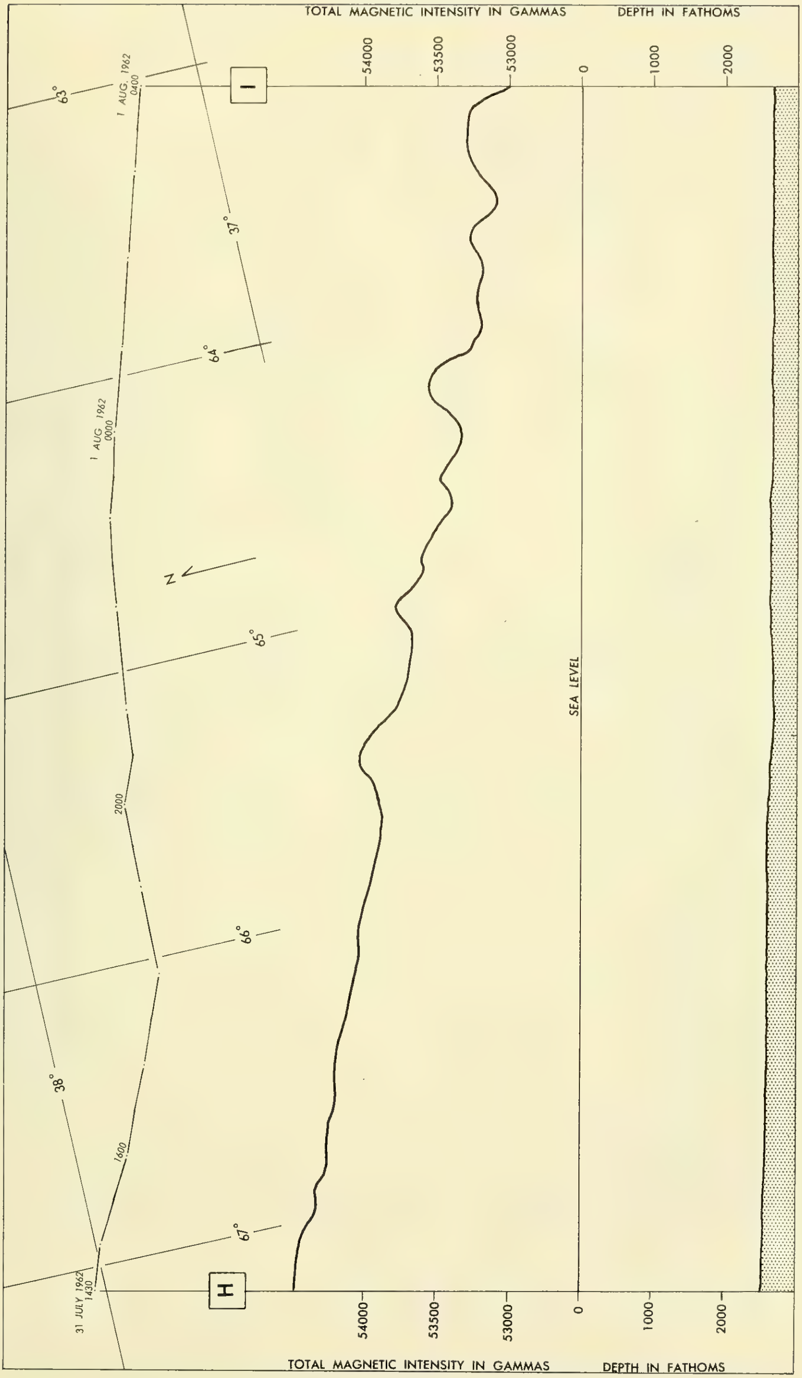

FIGURE 12.—MAGNETIC AND BATHYMETRIC PROFILES H-I

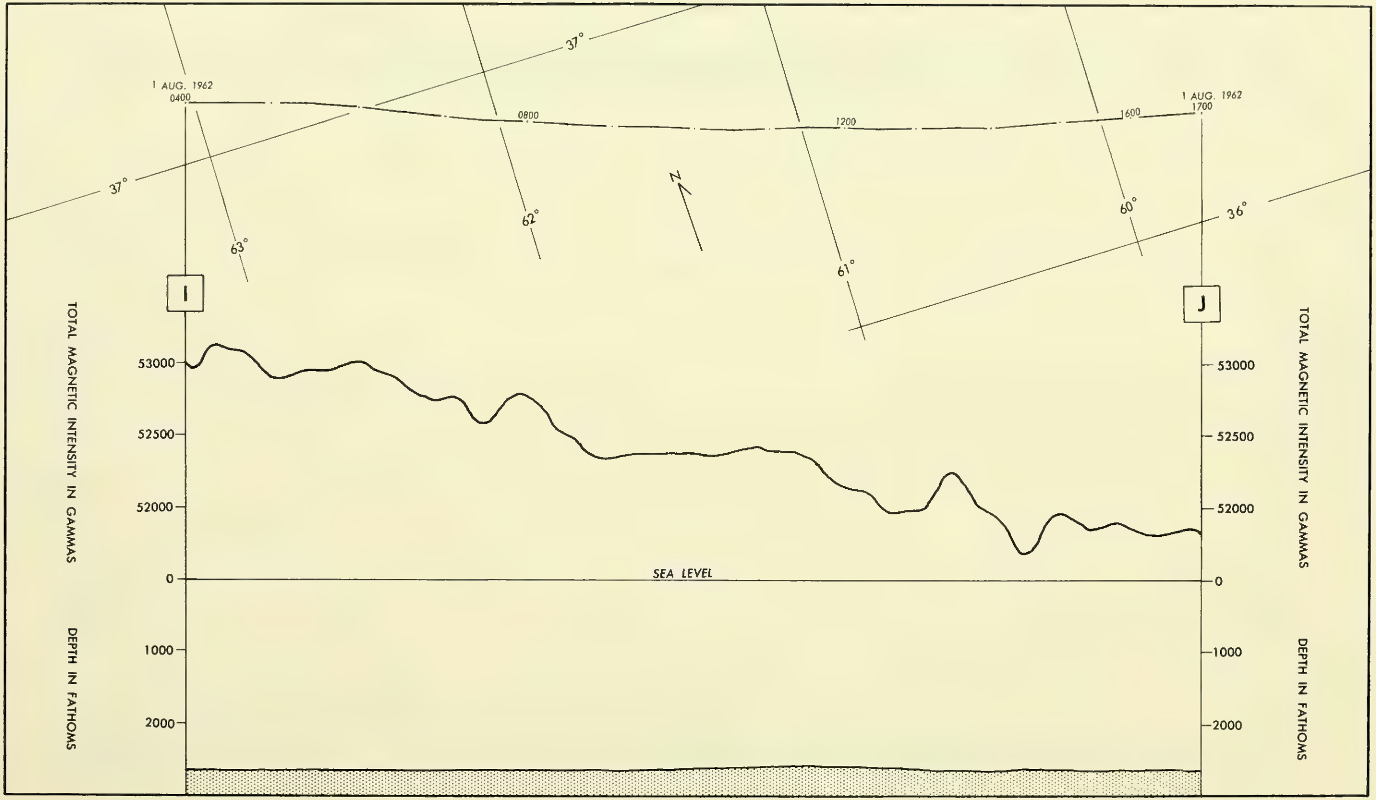

FIGURE 13.— MAGNETIC AND BATHYMETRIC PROFILES I-J

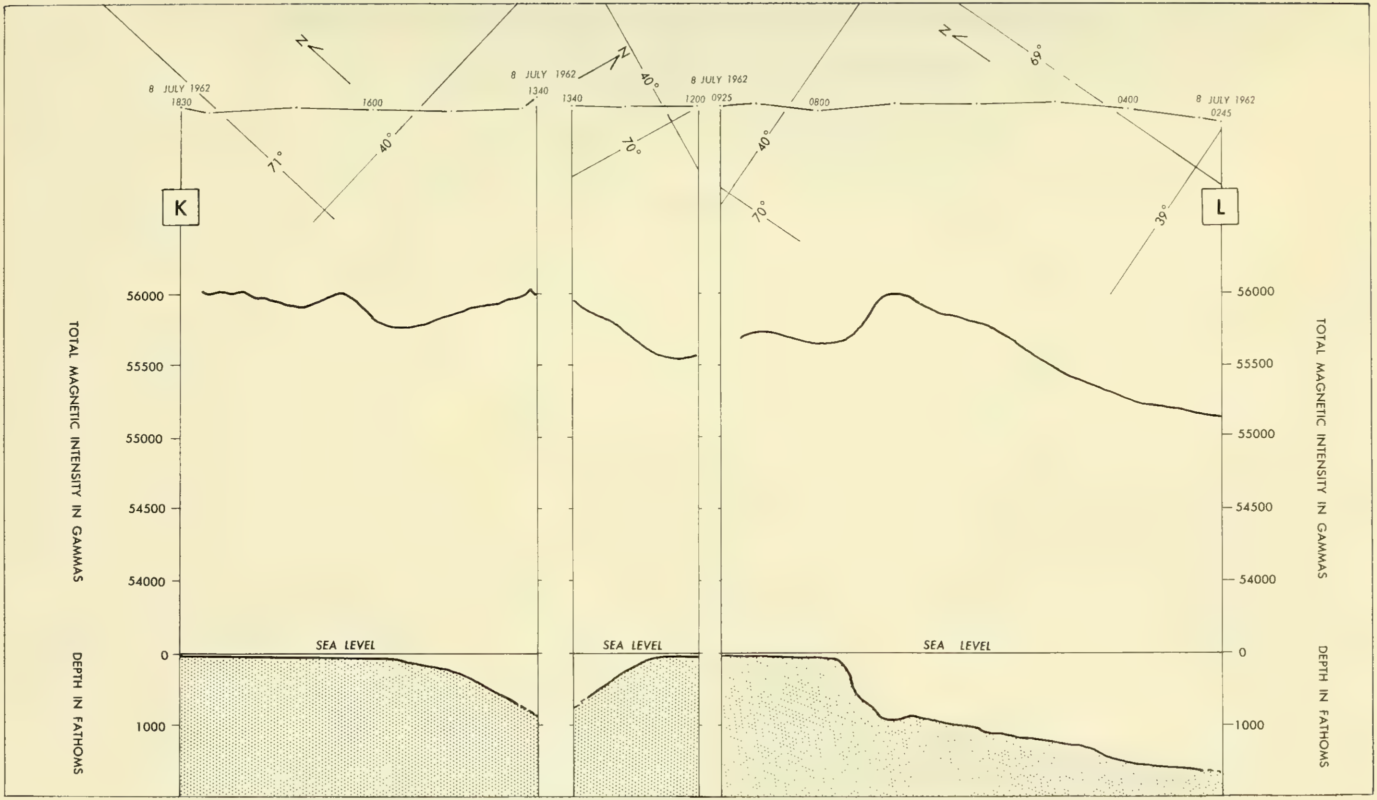

FIGURE 14.—MAGNETIC AND BATHYMETRIC PROFILES K-L

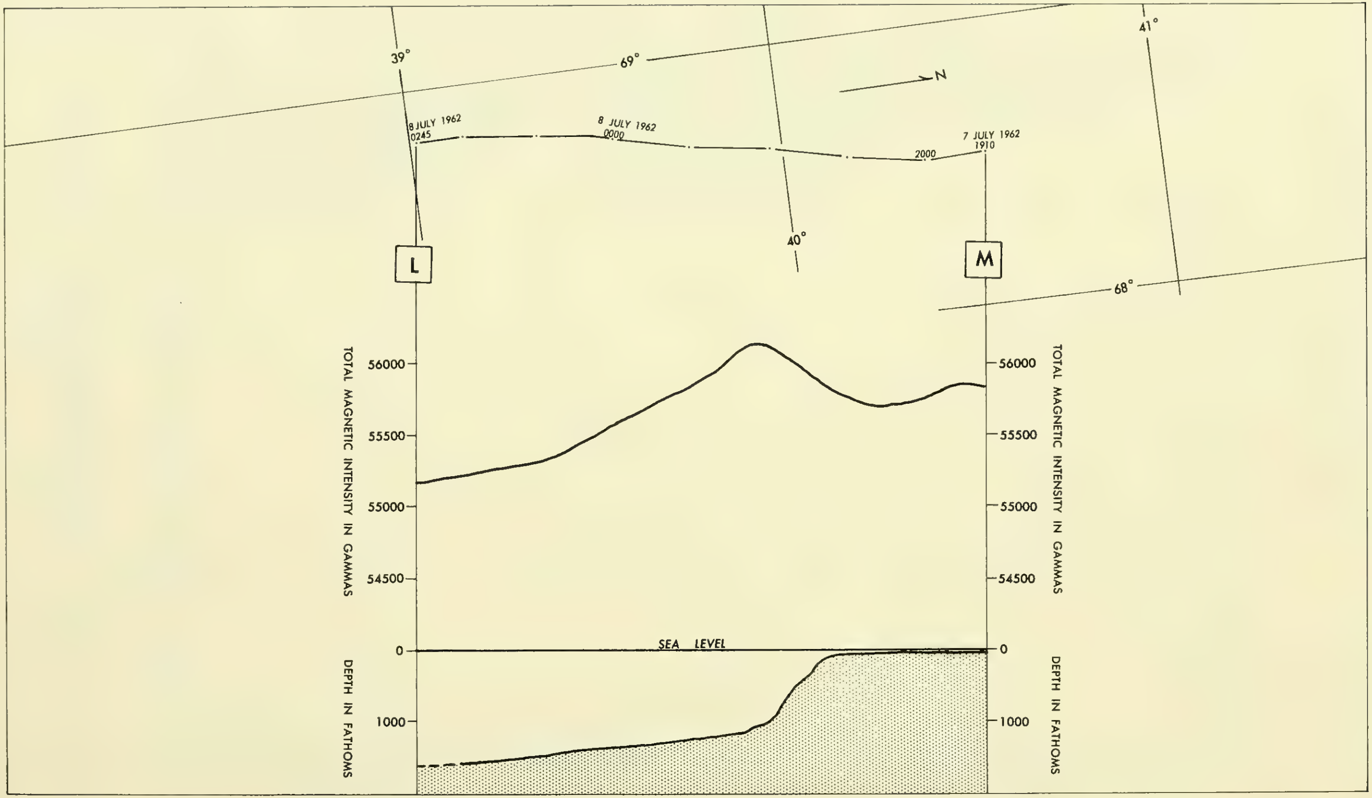

FIGURE 15.— MAGNETIC AND BATHYMETRIC PROFILES L-M

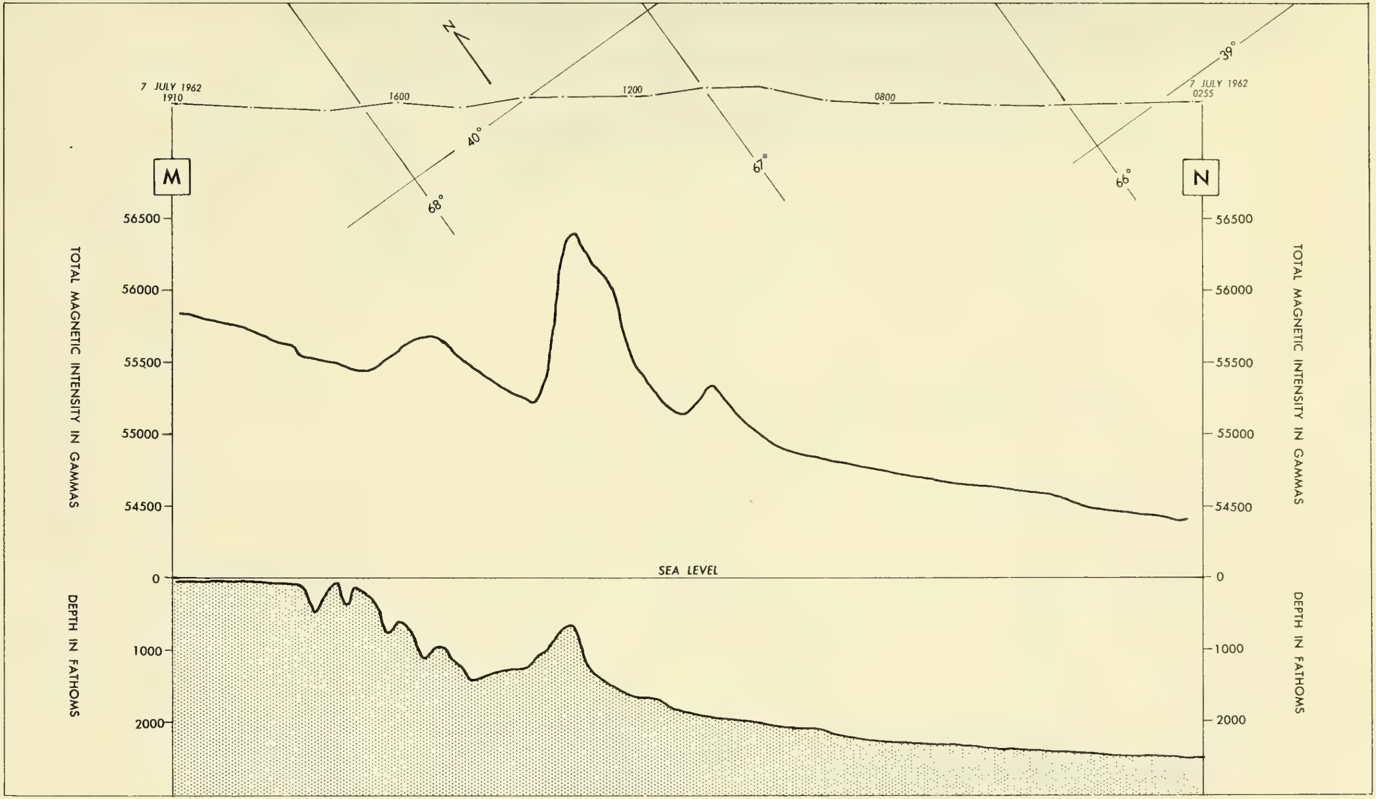

FIGURE 16.—MAGNETIC AND BATHYMETRIC PROFILES M-N

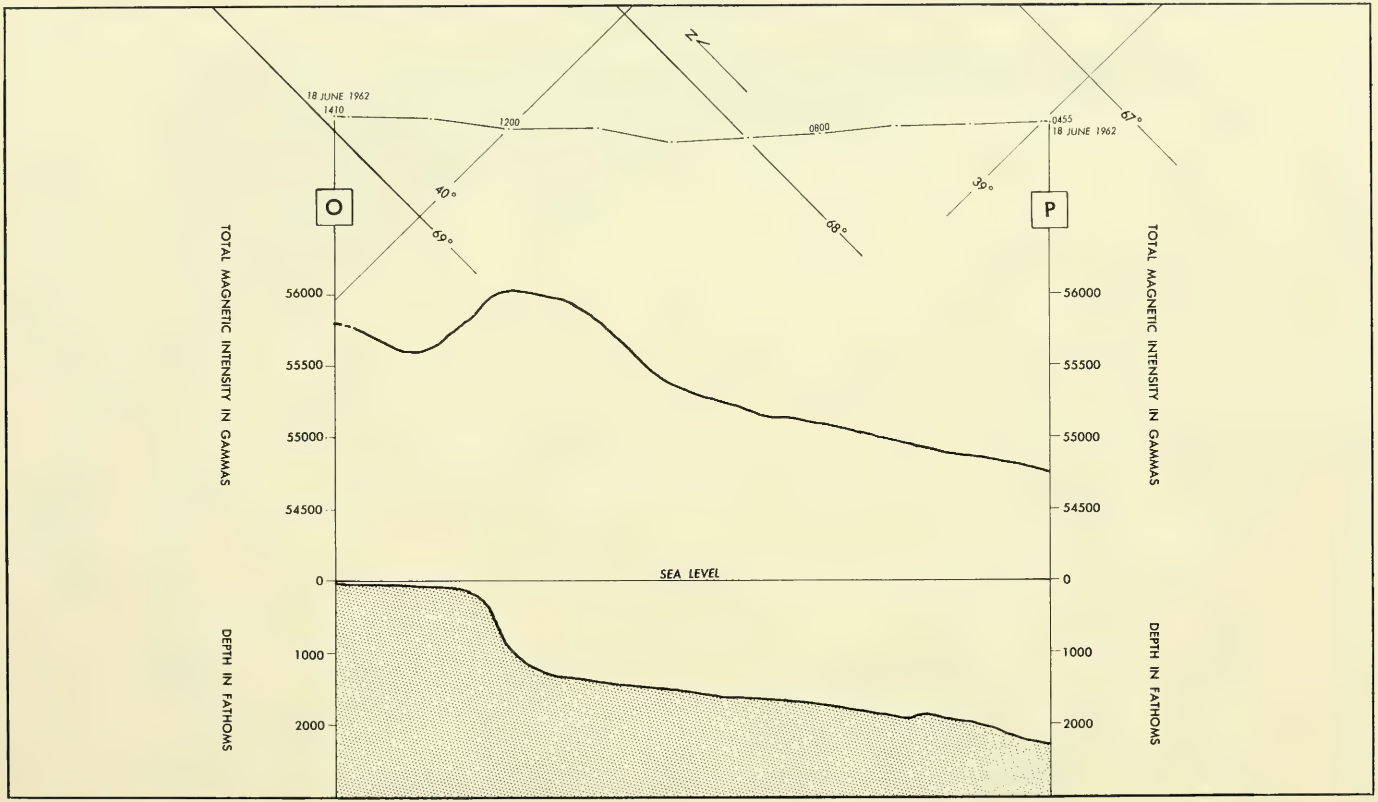

FIGURE 17.— MAGNETIC AND BATHYMETRIC PROFILES O-P

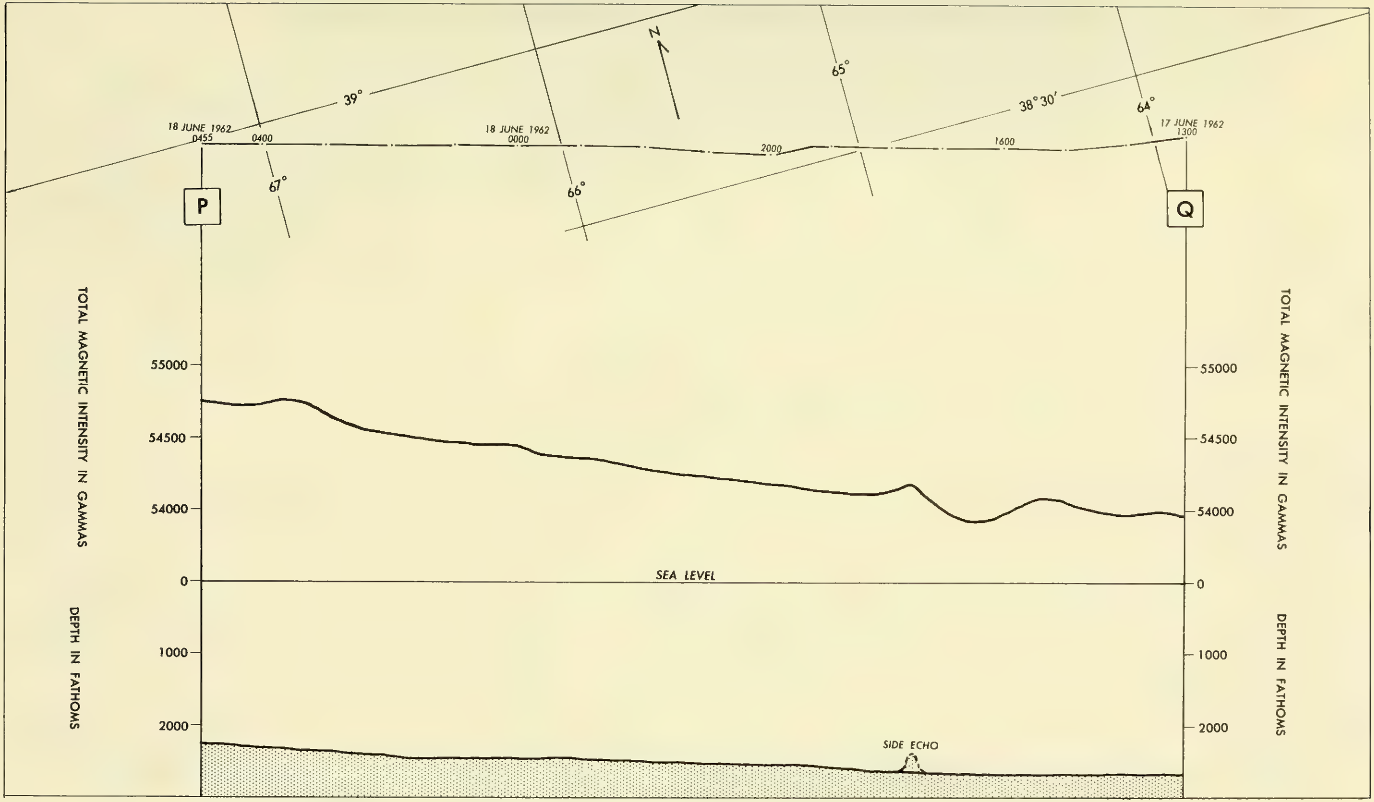

FIGURE 18.— MAGNETIC AND BATHYMETRIC PROFILES P-Q

FIGURE 19.— MAGNETIC AND BATHYMETRIC PROFILES R-S

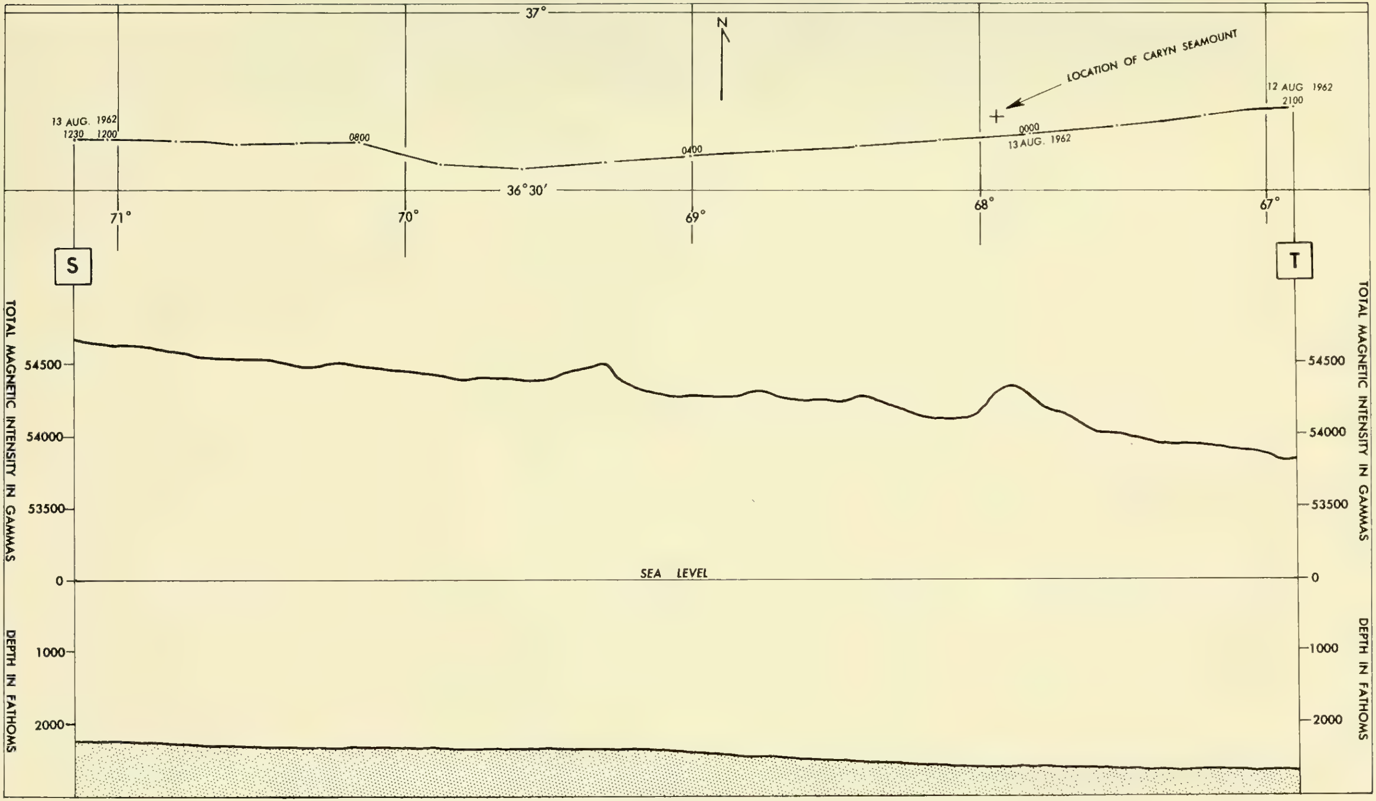

FIGURE 20.— MAGNETIC AND BATHYMETRIC PROFILES S-T

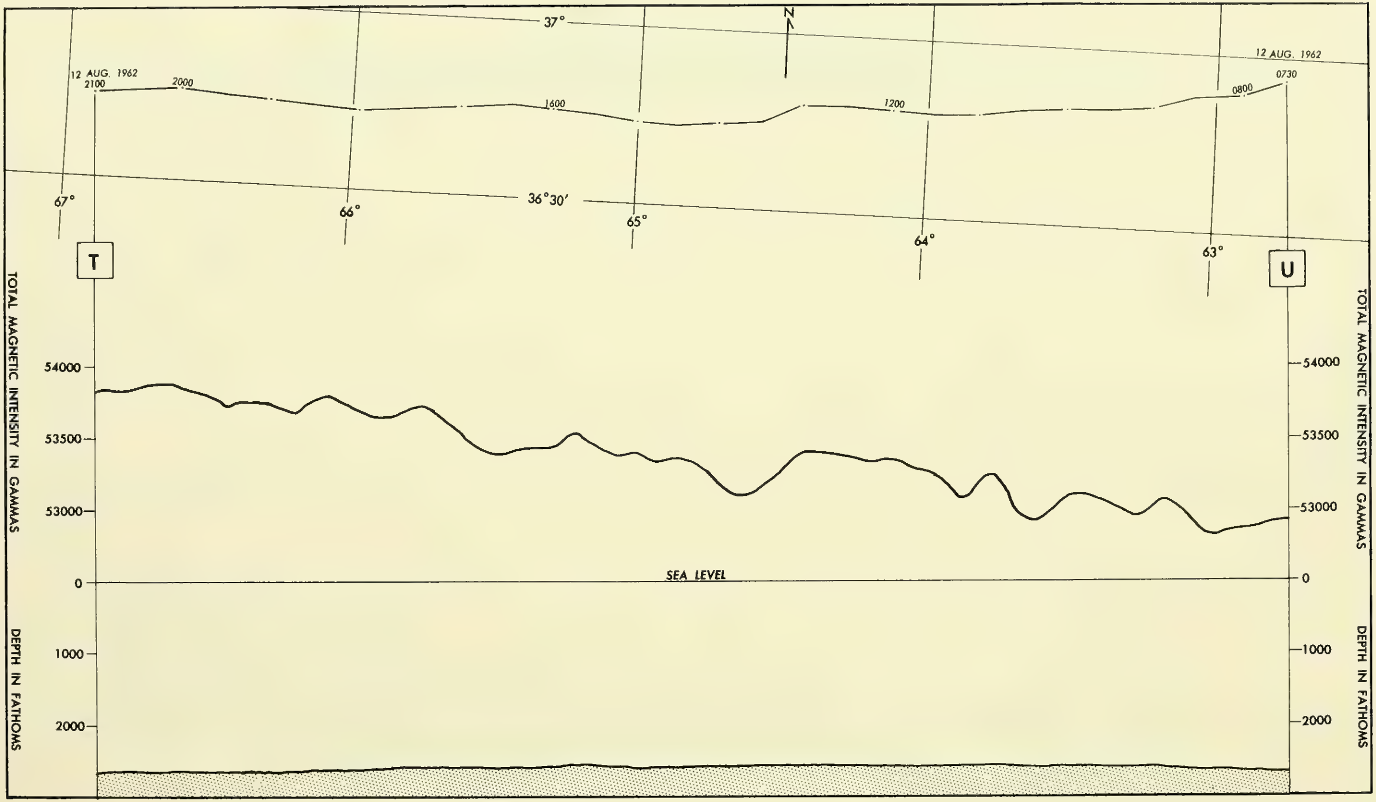

FIGURE 21.— MAGNETIC AND BATHYMETRIC PROFILES T-U

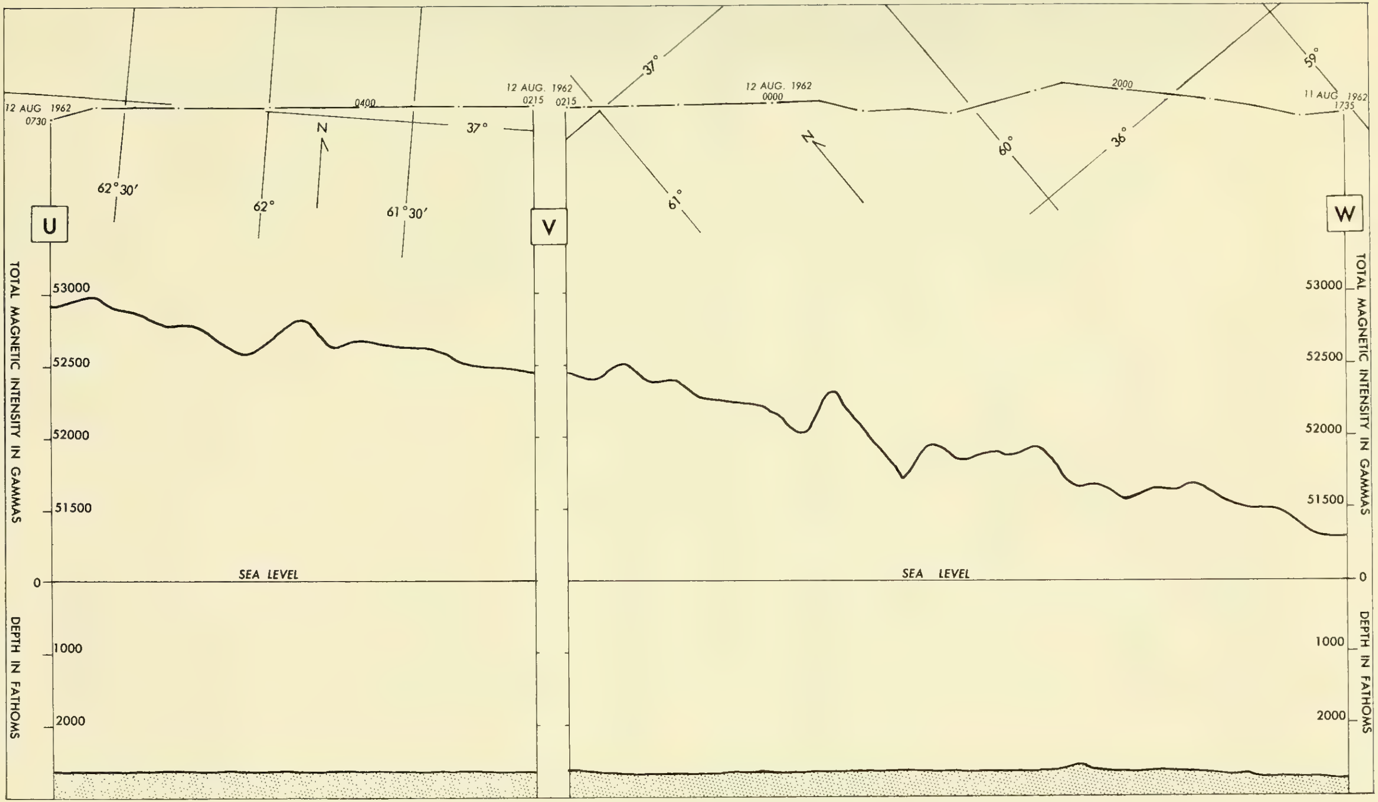

FIGURE 22.—MAGNETIC AND BATHYMETRIC PROFILES U-V-W

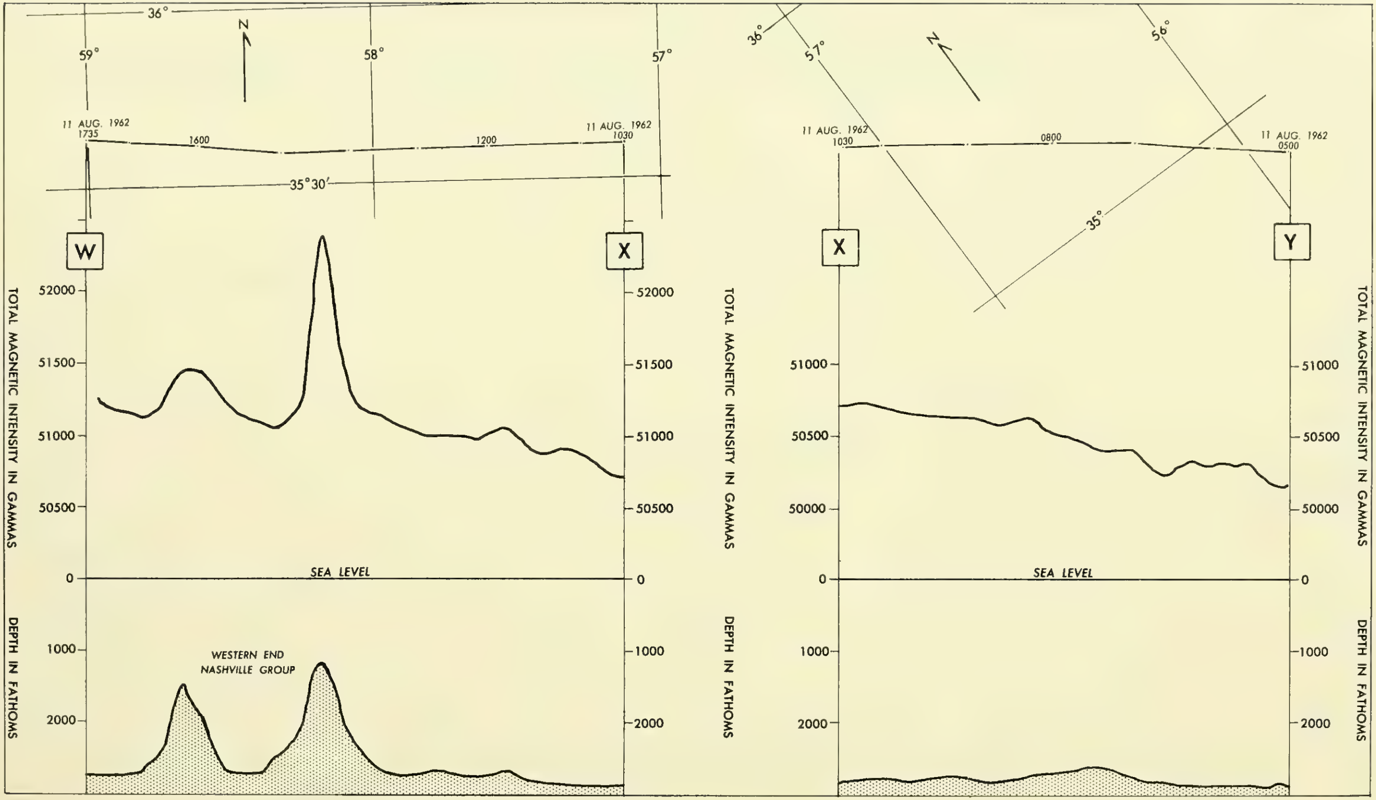

FIGURE 23.— MAGNETIC AND BATHYMETRIC PROFILES W-X-Y

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